

# Claims

[c1] WHAT IS CLAIMED:

1.A drill bit, comprising:

a spindle;

a rolling cutter positioned around said spindle, said rolling cutter having a seal recess formed therein, said seal recess having an outer surface; and

a lip seal positioned in said seal recess and around said spindle, wherein at least one void is established between said outer surface of said seal recess and an outer surface of said lip seal.

[c2] 2.The drill bit of claim 1, wherein said lip seal and said seal recess are sized and configured to provide an interference fit between said lip seal and said seal recess when said lip seal is positioned in said seal recess.

[c3] 3.The drill bit of claim 1, wherein said seal recess has a generally rectangular cross-sectional configuration.

[c4] 4.The drill bit of claim 1, wherein said outer surface of said seal recess is comprised of a flat surface.

[c5] 5.The drill bit of claim 1, wherein said outer surface of said seal recess is comprised of at least one concave

surface.

- [c6] 6.The drill bit of claim 1, wherein said seal recess further comprises a plurality of corners and said lip seal is comprised of a plurality of protrusions, said protrusions adapted to at least partially engage said corners of said seal recess when said lip seal is positioned in said seal recess.
- [c7] 7.The drill bit of claim 1, wherein said seal recess further comprises a plurality of radiused corners and said lip seal is comprised of a plurality of radiused protrusions, said radiused protrusions adapted to engage said radiused corners of said seal recess when said lip seal is positioned in said seal recess.
- [c8] 8.The drill bit of claim 1, wherein said outer surface of said lip seal is comprised of at least one concave surface.
- [c9] 9.The drill bit of claim 1, wherein said outer surface of said lip seal is comprised of a flat surface.
- [c10] 10.The drill bit of claim 1, wherein said outer surface of said lip seal is comprised of at least one concave surface having a radius of curvature.
- [c11] 11.The drill bit of claim 1, wherein said outer surface of said lip seal is comprised of a plurality of radiused pro-

trusions and a radiused concave surface positioned between said radiused protrusions.

- [c12] 12.The drill bit of claim 1, wherein said at least one void is adapted to be at least partially collapsed when said drill bit is subjected to hydrostatic pressure in a well bore.
- [c13] 13.The drill bit of claim 1, wherein said at least one void is adapted to be at least partially collapsed when said drill bit is subjected to hydrostatic pressure in a well bore and thereby create at least an axial force when said at least one void is at least partially collapsed that tends to secure said lip seal in said seal recess.
- [c14] 14.The drill bit of claim 1, wherein said lip seal is comprised of an elastomeric material.
- [c15] 15.The drill bit of claim 1, wherein said at least one void is a single void.
- [c16] 16.The drill bit of claim 1, wherein said at least one void has a volumetric size that ranges from approximately 0.5–15% of a volumetric size of said lip seal.
- [c17] 17.The drill bit of claim 1, wherein said at least one void has a volumetric size that ranges from approximately 2–6% of a volumetric size of said lip seal.

- [c18] 18. The drill bit of claim 1, wherein said at least one void has a volumetric size of approximately 4% of a volumetric size of said lip seal.
- [c19] 19. A drill bit, comprising:  
a spindle;  
a rolling cutter positioned around said spindle, said rolling cutter having a seal recess formed therein, said seal recess having an outer surface; and  
a lip seal positioned in said seal recess and around said spindle, said lip seal and said seal recess being sized and configured to provide an interference fit between said lip seal and said seal recess when said lip seal is positioned in said seal recess, wherein at least one void is established between said outer surface of said seal recess and an outer surface of said lip seal, said at least one void being adapted to be at least partially collapsed when said drill bit is subjected to hydrostatic pressure in a well bore.
- [c20] 20. The drill bit of claim 19, wherein said seal recess has a generally rectangular cross-sectional configuration.
- [c21] 21. The drill bit of claim 19, wherein said outer surface of said seal recess is comprised of a flat surface.
- [c22] 22. The drill bit of claim 19, wherein said outer surface of

said seal recess is comprised of at least one concave surface.

- [c23] 23.The drill bit of claim 19, wherein said seal recess further comprises a plurality of corners and said lip seal is comprised of a plurality of protrusions, said protrusions adapted to at least partially engage said corners of said seal recess when said lip seal is positioned in said seal recess.
- [c24] 24.The drill bit of claim 19, wherein said seal recess further comprises a plurality of radiused corners and said lip seal is comprised of a plurality of radiused protrusions, said radiused protrusions adapted to engage said radiused corners of said seal recess when said lip seal is positioned in said seal recess.
- [c25] 25.The drill bit of claim 19, wherein said outer surface of said lip seal is comprised of at least one concave surface.
- [c26] 26.The drill bit of claim 1, wherein said outer surface of said lip seal is comprised of a flat surface.
- [c27] 27.The drill bit of claim 19, wherein said outer surface of said lip seal is comprised of at least one concave surface having a radius of curvature.
- [c28] 28.The drill bit of claim 19, wherein said outer surface of

said lip seal is comprised of a plurality of radiused protrusions and a radiused concave surface positioned between said radiused protrusions.

- [c29] 29.The drill bit of claim 19, wherein said at least one void is adapted to create at least an axial force when said at least one void is at least partially collapsed that tends to secure said lip seal in said seal recess.
- [c30] 30.The drill bit of claim 19, wherein said lip seal is comprised of an elastomeric material.
- [c31] 31.The drill bit of claim 19, wherein said at least one void is a single void.
- [c32] 32.The drill bit of claim 19, wherein said at least one void has a volumetric size that ranges from approximately 0.5–15% of a volumetric size of said lip seal.
- [c33] 33.The drill bit of claim 19, wherein said at least one void has a volumetric size that ranges from approximately 2–6% of a volumetric size of said lip seal.
- [c34] 34.The drill bit of claim 19, wherein said at least one void has a volumetric size of approximately 4% of a volumetric size of said lip seal.
- [c35] 35.A drill bit, comprising:  
a spindle;

a rolling cutter positioned around said spindle, said rolling cutter having a seal recess formed therein, said seal recess having an outer surface and a plurality of corners; and

a lip seal positioned in said seal recess and around said spindle, said lip seal having at least one outer concave surface and a plurality of protrusions positioned proximate said outer concave surface, wherein said protrusions are adapted to at least partially engage said corners of said seal recess when said lip seal is positioned in said seal recess, and wherein at least one void is established between said outer surface of said seal recess and said at least one outer concave surface of said lip seal.

[c36] 36.The drill bit of claim 35, wherein said lip seal and said seal recess are sized and configured to provide an interference fit between said lip seal and said seal recess when said lip seal is positioned in said seal recess.

[c37] 37.The drill bit of claim 35, wherein said seal recess has a generally rectangular cross-sectional configuration.

[c38] 38.The drill bit of claim 35, wherein said outer surface of said seal recess is comprised of a flat surface.

[c39] 39.The drill bit of claim 35, wherein said plurality of cor-

ners in said seal recess are radiused corners, and wherein said protrusions on said lip seal are radiused protrusions.

[c40] 40.The drill bit of claim 35, wherein said at least one outer concave surface of said lip seal has a radius of curvature.

[c41] 41.The drill bit of claim 35, wherein said at least one void is adapted to be at least partially collapsed when said drill bit is subjected to hydrostatic pressure in a well bore.

[c42] 42.The drill bit of claim 35, wherein said at least one void is adapted to be at least partially collapsed when said drill bit is subjected to hydrostatic pressure in a well bore and thereby create at least an axial force when said at least one void is at least partially collapsed that tends to secure said lip seal in said seal recess.

[c43] 43.The drill bit of claim 35, wherein said lip seal is comprised of an elastomeric material.

[c44] 44.The drill bit of claim 35, wherein said at least one void is a single void.

[c45] 45.The drill bit of claim 35, wherein said at least one void has a volumetric size that ranges from approxi-



mately 0.5–15% of a volumetric size of said lip seal.

[c46] 46.The drill bit of claim 35, wherein said at least one void has a volumetric size that ranges from approximately 2–6% of a volumetric size of said lip seal.

[c47] 47.The drill bit of claim 35, wherein said at least one void has a volumetric size of approximately 4% of a volumetric size of said lip seal.

[c48] 48.A drill bit, comprising:  
a spindle;  
a rolling cutter positioned around said spindle, said rolling cutter having a seal recess formed therein, said seal recess having an outer surface and a plurality of radiused corners; and  
an elastomeric lip seal positioned in said seal recess and around said spindle, said lip seal having an outer concave surface and a plurality of radiused protrusions positioned proximate said outer concave surface, wherein said radiused protrusions are adapted to at least partially engage said radiused corners of said seal recess when said lip seal is positioned in said seal recess, and wherein a void is established between said outer surface of said seal recess and said outer concave surface of said lip seal.

[c49] 49.A method, comprising:  
providing a drill bit comprised of:  
a spindle;  
a rolling cutter positioned around said spindle, said  
rolling cutter having a seal recess formed therein, said  
seal recess having an outer surface; and  
a lip seal positioned in said seal recess and around said  
spindle, wherein at least one void is established between  
said outer surface of said seal recess and an outer sur-  
face of said lip seal;  
positioning said drill bit in a well bore wherein said at  
least one void is at least partially collapsed when said  
drill bit is subjected to hydrostatic pressure in said well  
bore; and  
performing drilling operations with said drill bit.

[c50] 50.The method of claim 49, wherein said lip seal and  
said seal recess are sized and configured to provide an  
interference fit between said lip seal and said seal recess  
when said lip seal is positioned in said seal recess.

[c51] 51.The method of claim 49, wherein said seal recess has  
a generally rectangular cross-sectional configuration.

[c52] 52.The method of claim 49, wherein said outer surface  
of said seal recess is comprised of a flat surface.

- [c53] 53.The method of claim 1, wherein said outer surface of said seal recess is comprised of at least one concave surface.
- [c54] 54.The method of claim 49, wherein said seal recess further comprises a plurality of corners and said lip seal is comprised of a plurality of protrusions, said protrusions adapted to at least partially engage said corners of said seal recess when said lip seal is positioned in said seal recess.
- [c55] 55.The method of claim 49, wherein said seal recess further comprises a plurality of radiused corners and said lip seal is comprised of a plurality of radiused protrusions, said radiused protrusions adapted to engage said radiused corners of said seal recess when said lip seal is positioned in said seal recess.
- [c56] 56.The method of claim 49, wherein said outer surface of said lip seal is comprised of at least one concave surface.
- [c57] 57.The method of claim 1, wherein said outer surface of said lip seal is comprised of a flat surface.
- [c58] 58.The method of claim 49, wherein said outer surface of said lip seal is comprised of at least one concave surface having a radius of curvature.

- [c59] 59. The method of claim 49, wherein said outer surface of said lip seal is comprised of a plurality of radiused protrusions and a radiused concave surface positioned between said radiused protrusions.
- [c60] 60. The method of claim 49, wherein when said at least one void is at least partially collapsed, at least an axial force is created that tends to secure said lip seal in said seal recess.
- [c61] 61. The method of claim 49, wherein said lip seal is comprised of an elastomeric material.
- [c62] 62. The method of claim 49, wherein said at least one void is a single void.
- [c63] 63. The method of claim 49, wherein said at least one void has a volumetric size that ranges from approximately 0.5–15% of a volumetric size of said lip seal.
- [c64] 64. The method of claim 49, wherein said at least one void has a volumetric size that ranges from approximately 2–6% of a volumetric size of said lip seal.
- [c65] 65. The method of claim 49, wherein said at least one void has a volumetric size of approximately 4% of a volumetric size of said lip seal.